Performance of HP ProLiant DL585 G5 server with Quad-Core AMD Opteron processors (2.5 GHz) in a 64-bit HP SBC environment

Executive summary

The HP ProLiant DL585 G5 is a highly manageable, rack-optimized, four-socket[1] server designed for maximum performance in an industry-standard architecture. With up to four Quad-Core AMD Opteron™ processors and a large memory footprint, the HP ProLiant DL585 G5 server delivers the performance and performance-per-watt needed for compute-hungry database, virtualization, and consolidation applications. Its impressive remote management capabilities can help reduce your costs and improve your ability to respond quickly to business changes.

Key benefits include:

- Outstanding performance and reliability
- Industry-leading management options
- Flexibility for a variety of enterprise deployments
- High performance-per-watt

A 4P HP ProLiant DL585 G5 server equipped with the Quad-Core AMD Opteron Processor Model 8360 SE (2.5 GHz) can provide optimal support for up to the following numbers of users (as described in Table 2) in a 64-bit HP Server Based Computing (SBC) environment:

Heavy Users	288
Medium Users	444
Light Users	528

Since the kernel memory constraints that limit scalability in a 32-bit HP SBC environment have been removed, this performance characterization demonstrates that customers can expect to fully utilize the resources of this server in a 64-bit environment, even when running their 32-bit applications.

Target audience: This performance characterization is intended primarily for IT professionals planning HP SBC solution deployments. The performance and sizing information provided herein is designed to help customers estimate the number of HP ProLiant DL585 G5 servers required for a particular environment.

Testing performed in June 2008 is described.

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[1] Four-processor, also known as 4P

Introduction

The HP ProLiant DL585 G5 server (shown in Figure 1) is ideal for multi-threaded, multi-tasked environments, high-performance computing, and HP SBC.

Figure 1. HP ProLiant DL585 G5 server

AMD Opteron processors

The HP ProLiant DL585 G5 server supports up to four Quad-Core AMD Opteron 8300 Series processors. This native quad-core processor delivers the following benefits:

- **Outstanding performance**
  The Quad-Core AMD Opteron processor is designed for optimal multi-threaded application performance. Its native quad-core implementation features four cores on a single die for more efficient data sharing, while the enhanced cache structure and integrated memory controller can sustain application throughput. This processor provides outstanding processing power and, together with its performance-per-watt enhancements, can improve IT responsiveness while maintaining data center costs.

- **Enhanced power efficiency**
  Thanks to Enhanced AMD PowerNow!™ technology and the introduction of AMD CoolCore™ technology, Quad-Core AMD Opteron processors are very power-efficient, helping to reduce power needs and cooling costs in the data center.
  (For more on power management enhancements, see AMD Dual Dynamic Power Management.)

- **Optimal virtualization**
  Featuring AMD Virtualization™ (AMD-V™) technology with nested paging acceleration, Quad-Core AMD Opteron processors can accelerate the performance of virtualized applications and improve efficiency when switching between virtual machines; as a result, customers can typically host more virtual machines and users per system, maximizing the consolidation and power-saving benefits of virtualization.

- **Investment protection**
  By leveraging AMD's Common Core Strategy and Same Socket Technology, Quad-Core AMD Opteron processors can minimize changes to the customer's software and data center infrastructure, protecting IT investments and simplifying management.

AMD Dual Dynamic Power Management

Without compromising performance, AMD Dual Dynamic Power Management functionality allows each processor to maximize the power-saving benefits of Enhanced AMD PowerNow! by reducing idle power consumption and enabling per-processor power management in multi-socket systems to further reduce power consumption.

By powering core and memory controller voltage planes independently, AMD Dual Dynamic Power Management can enhance both performance and power management.

Benefits include:

- **Increased performance**
  The memory controller is able to run at a higher frequency, helping to reduce memory latency and thus improving application performance.
- **Improved power management**
  By operating independently from the memory controller, the cores in a Quad-Core AMD Opteron processor can exploit the power savings offered by Enhanced AMD PowerNow! more often, resulting in reduced power and cooling bills. In addition, the processor reduces power to the northbridge[2] when memory is not in use, while continuing to provide full power to the cores.

The following sections of this paper describe the testing performed by HP to characterize the performance and scalability of an HP ProLiant DL585 G5 server in a 64-bit HP SBC environment.

Note:

A 64-bit HP SBC environment eliminates the kernel memory constraints that can limit server scalability in a 32-bit HP SBC environment. For more information, refer to Appendix A – Using Microsoft Windows Server 2003 x64 Editions.

Test methodology

HP continues to upgrade existing HP ProLiant servers and introduce new servers to meet particular business needs. To help customers select the appropriate server for their particular HP SBC environment, HP publishes this and other performance characterizations so that you can compare individual server performance and scalability.

This section describes how HP determined the optimal number of users supported by a 4P HP ProLiant DL585 G5 server equipped with the Quad-Core AMD Opteron Processor Model 8360 HE[3] (2.5 GHz) – henceforth referred to as the HP ProLiant DL585 G5 server – in a 64-bit test harness.

Important:

As with any laboratory testing, the performance metrics quoted in this paper are idealized. In a production environment, these metrics may be impacted by a variety of factors.

HP recommends proof-of-concept testing in a non-production environment using the actual target application as a matter of best practice for all application deployments. Testing the actual target application in a test/staging environment identical to, but isolated from, the production environment is the most effective way to characterize system behavior.

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[2] Or memory controller hub (MCH)

[3] HE processors are higher power, frequency-optimized devices.

This section provides more information on test tools, user profiles and test scenarios.

Test tools

To facilitate the placement and management of simulated loads on an HP SBC server, HP used Terminal Services Scalability Planning Tools (TSScaling), a suite of tools developed by Microsoft to help organizations with Microsoft Windows® Server 2003 Terminal Server capacity planning.

Table 1 describes these tools.

Table 1. Components of TSScaling

Component		Description
Automation tools	Robosrv.exe	Drives the server-side of the load simulation
	Robocli.exe	Helps drive the client-side of the load simulation
Test tools	Qidle.exe	Determines if any scripts have failed and require operator intervention
	Tbscript.exe	A script interpreter that helps drive the client-side load simulation
Help files	TBScript.doc	Terminal Server bench scripting documentation
	TSScalingSetup.doc	A scalability test environment set-up guide
	TSScalingTesting.doc	A testing guide

More information
- Roboserver (Robosrv.exe) and Roboclient (Robocli.exe): Terminal Server capacity planning
- TSScaling: Windows Server 2003 Terminal Server Capacity and Scaling

User profiles

To simulate typical workloads in this environment, HP used scripts based on the Heavy, Medium, and Light User profiles described in Table 2.

Table 2. User profiles incorporated into the test scripts

User class	Activities
Heavy User	Heavy Users (also known as Structured Task Workers) tend to open multiple applications simultaneously and remain active for long periods. Heavy Users often leave applications open when not in use.
Medium User	Medium Users (also known as Knowledge Workers) are defined as users who gather, add value to, and communicate information in a decision-support process. Cost of downtime is variable but highly visible. These resources are driven by projects and ad-hoc needs towards flexible tasks. These workers make their own decisions on what to work on and how to accomplish the task. Sample tasks include: marketing, project management, sales, desktop publishing, decision support, data mining, financial analysis, executive and supervisory management, design, and authoring.
Light User	Light Users (also known as Data Entry Workers) input data into computer systems. Activities include transcription, typing, order entry, clerical work and manufacturing.

Table 3 outlines the activities performed by each user class utilizing Office 2003 products.

Table 3. Activities incorporated into the test scripts for each user class

Activity description		Heavy User	Medium User	Light User
Access	Open a database, apply a filter, search through records, add records, and delete records.	X		
Excel	Open, print and save a large spreadsheet.	X	X	X
Excel_2	Create a new spreadsheet, enter data, and create a chart. Print and save the spreadsheet.		X	X
InfoPath	Enter data[4] into a form; save the form over an existing form.	X	X	
Outlook	First pass: Email a short message. Second pass: Email a reply with an attachment.	X		
Outlook_2	Create a long reply.	X		
PowerPoint	Create a new presentation, insert clipart, and apply animation. View the presentation after each slide is created.	X	X	
PowerPoint2	Open and view a large presentation with heavy animation and many colors and gradients.	X		
Word	Create, save, print, and email a document.	X[5]	X	X

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[4] Data entry for Office InfoPath 2003 requires significant processor resources
[5] Shortened version for Heavy Users

Test scenarios

For the Heavy User type, HP initiated testing by running the appropriate script with a group of 15 simulated users. Start times were staggered to eliminate authentication overhead. After these sessions finished, HP added 15 more users, then repeated the testing. Further groups of 15 users were added until the maximum number of users was reached.

For Medium and Light User types, HP utilized groups of ten users.

Performance and scalability metrics

While the scripts were running, HP monitored a range of Windows Performance Monitor (Perfmon) counters to help characterize server performance and scalability. In particular, HP has monitored CPU utilization (**% Processor Time**) to establish the optimal number of users supported on an HP SBC server – by definition, the number of users active when processor utilization reaches 80%. At this time, a limited number of additional users or services can be supported; however, user response times may become unacceptable.

To validate scalability metrics obtained using Perfmon, HP also runs canary scripts to characterize Heavy User response times – a very practical metric – for discrete activities such as an application being invoked or a modal box appearing. By monitoring response times as more and more users log on, HP has been able to demonstrate that these times are acceptable when the optimal number of users (as determined using Perfmon counter values) is active.
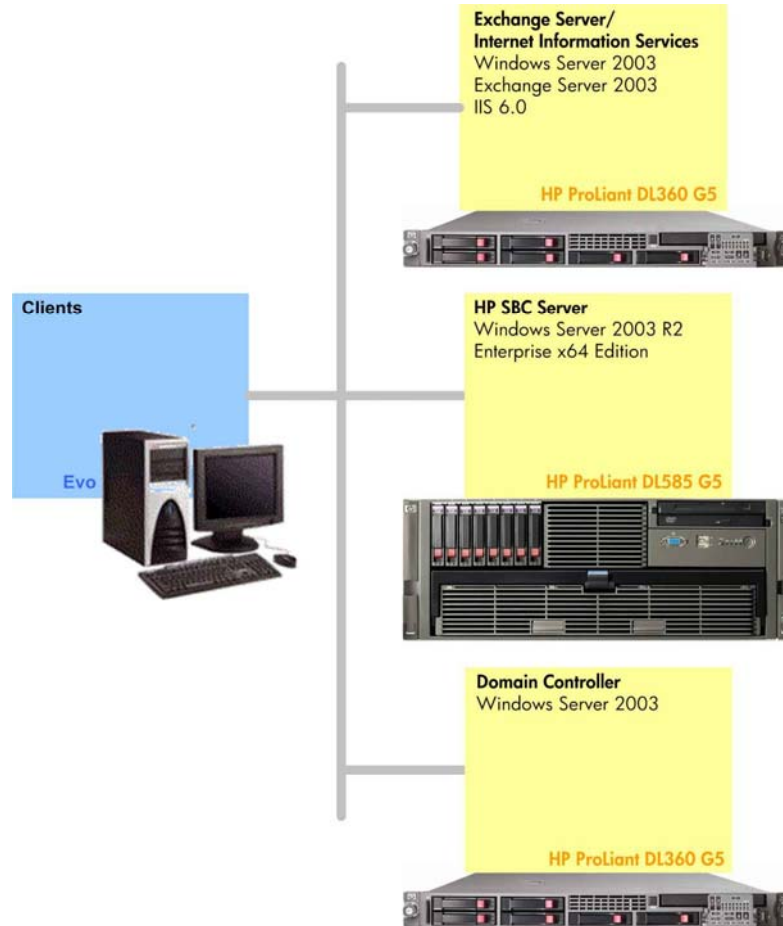
Note:
When running canary scripts, HP considers user response times to become unacceptable when they increase markedly over a baseline measurement.

Test topology

Figure 2 illustrates the HP SBC test environment.

Figure 2. The tested environment

Configurations

Table 4 summarizes the configurations of servers and clients used in the test environment.

Table 4. System configurations

Server	Configuration
HP SBC server	4P HP ProLiant DL585 G5 server with:
	• Quad-Core AMD Opteron Processor Model 8360 SE (2.5 GHz)
	– 512 KB L2 cache per core; 2 MB L3 cache
	• 32 GB RAM
	• Smart Array P400 controller with RAID 0
	• Four 72 GB 15,000 rpm SAS hard drives
	– 48 GB page file on system partition
	• NC371i Multifunction Gigabit Server Adapter
	Windows Server 2003 R2 Enterprise x64 Edition with Service Pack 2; Terminal Services enabled
	Office 2003
Exchange Server/ Internet Information Services	2P HP ProLiant DL360 G5 server with:
	• Dual-Core Intel® Xeon® processor (3.2 GHz)
	• 2 x 2 MB L2 cache
	• 2 GB RAM
	• Four 72 GB 15,000 rpm SAS hard drives
	• Integrated Smart Array P400i controller with RAID 5
	• NC373i Multifunction Gigabit Server Adapter
	Windows Server 2003 Enterprise Edition
	Microsoft Exchange Server 2003
	Microsoft Internet Information Services (IIS) 6.0
Domain Controller	2P HP ProLiant DL360 G5 server with:
	• Dual-Core Xeon processor (3.2 GHz)
	• 2 x 2 MB L2 cache
	• 2 GB RAM
	• Four 72 GB 15,000 rpm SAS hard drives
	• Integrated Smart Array P400i controller with RAID 5
	• NC373i Multifunction Gigabit Server Adapter
	Windows Server 2003 Enterprise Edition

Table 4. System configurations (continued)

Server	Configuration
Client	Variety of Intel Pentium®-based Compaq Evo workstations (600 MHz – 2.533 GHz), each with: • At least 256 MB of memory • 1024 x 768/16-bit color depth • 100 Mbps NIC
	Windows 2000 Professional or Windows XP

HP SBC server summary

Table 5 summarizes the configuration of the tested HP SBC server.

Table 5. System summary for the HP ProLiant DL585 G5 server

Component	Description
Operating system (OS)	Microsoft Windows Server 2003, Enterprise x64 Edition
Version	5.2.3790 Service Pack 2, Build 3790
Other OS description	R2
System name	DL585
System model	ProLiant DL585 G5
System type	x64-based PC
Processor	AMD64 Family 16 Model 2 Stepping 3 AuthenticAMD ~2512 MHz
BIOS version/date	HP A07, 3/28/2008
SMBIOS version	2.4
Windows directory	C:\WINDOWS
System directory	C:\WINDOWS\system32
Boot device	\Device\HarddiskVolume1
Locale	United States
Hardware abstraction layer version	5.2.3790.3959 (srv03_sp2_rtm.070216-1710)
User name	[Not available]
Time zone	New Zealand Standard Time

Continued

Table 5. System summary for the HP ProLiant DL585 G5 server (continued)

Component	Description
Total physical memory	32,765.62 MB
Available physical memory	30.63 GB
Total virtual memory	79.06 GB
Available virtual memory	78.54 GB
Page file space	48.00 GB
Page file	C:\pagefile.sys

Performance test results

This section outlines the test results used by HP to characterize the performance and scalability of the HP ProLiant DL585 G5 server.

- **Perfmon values** – Shows select Perfmon counter values for the Heavy User scenario
- **Canary times** – Shows Heavy User response times for a sample canary script

Note:
As with any laboratory benchmark, the performance metrics quoted in this performance brief are idealized. In a production environment, these metrics may be impacted by a variety of factors; for more information, refer to Appendix B – SBC solution sizing.

HP determined that there were no disk or network bottlenecks in the test environment.

Perfmon values

HP ran a series of performance tests using scripts based on the Heavy, Medium, and Light User profiles. Figure 3 shows the test results for Heavy Users.

Figure 3. **% Processor Time** values for Heavy Users – showing that 288 Heavy Users were supported when processor utilization reached 80%
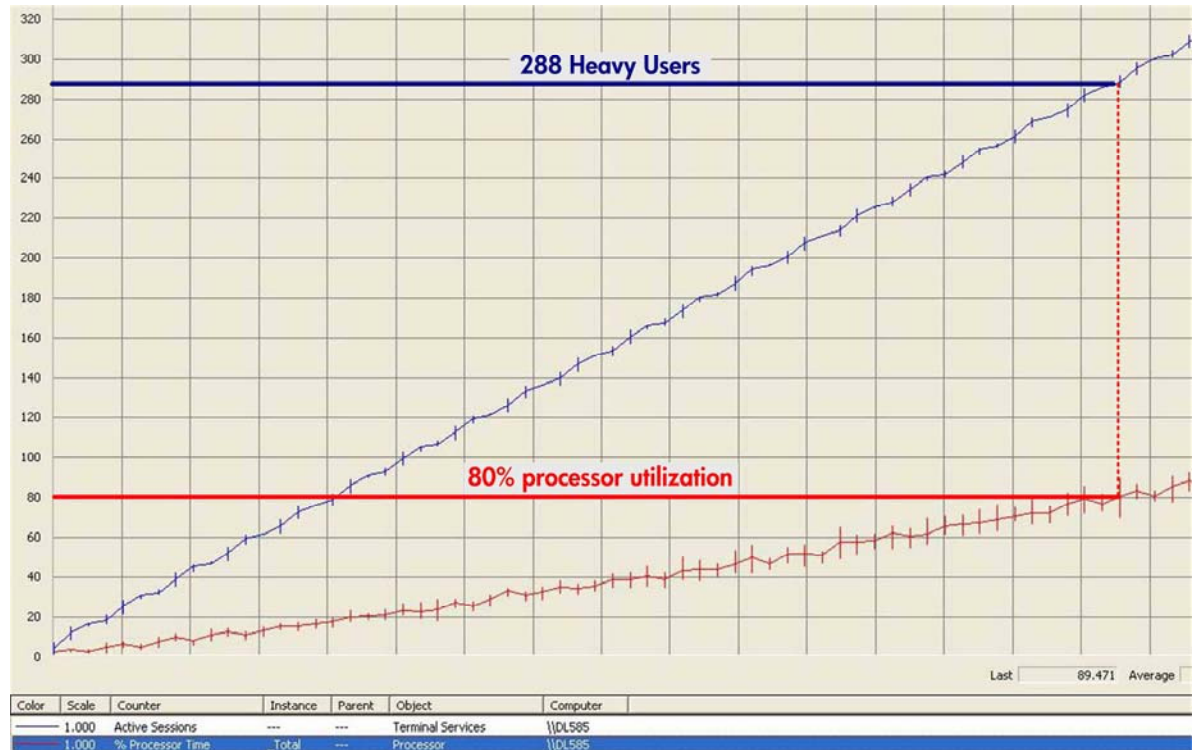

Figure 3 shows the optimal number of Heavy Users supported by the HP ProLiant DL585 G5 server to be 288.

Canary times

Figure 4 shows sample results for the HP ProLiant DL585 G5 server running a typical canary script.

Individual user response times are shown in blue, with a yellow line depicting average response times.

HP analyzed this figure to determine when response times began to increase markedly and consistently over a baseline level, indicating that user response times had become unacceptable.

Figure 4. Canary time values show that response times began to become unacceptable when 327 Heavy Users were active
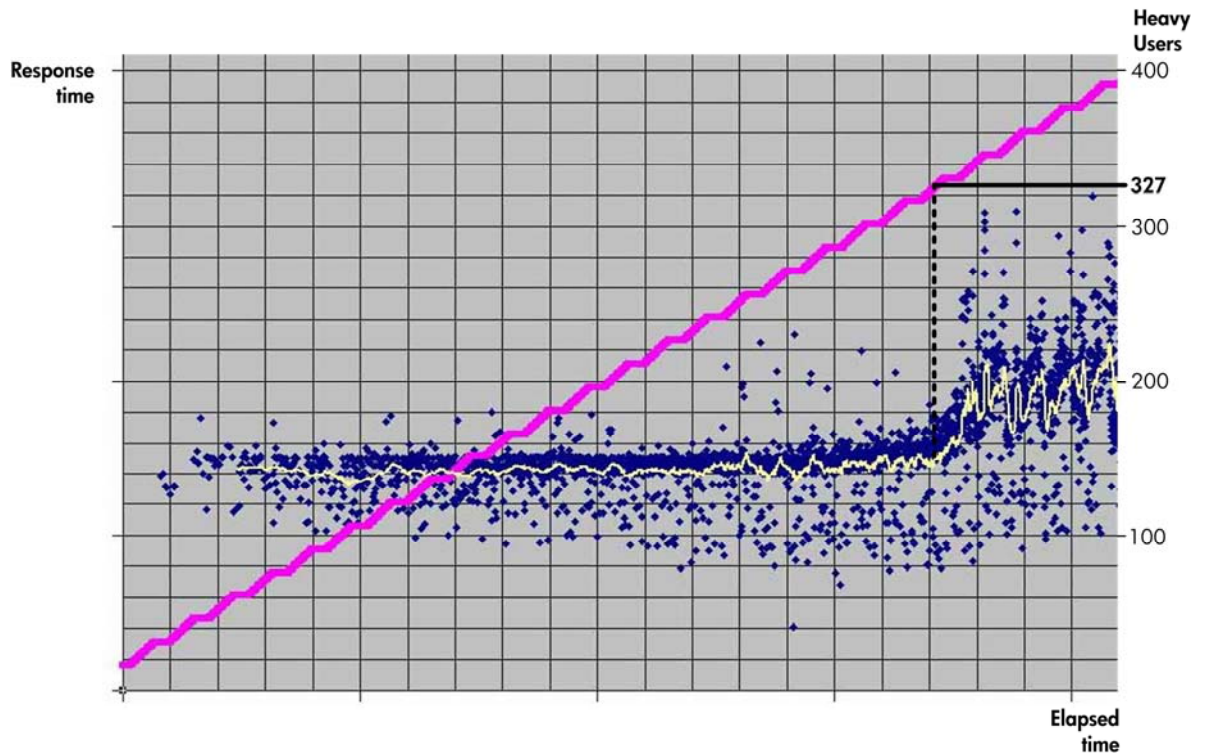

Figure 4 indicates that the HP ProLiant DL585 G5 server could support 327 Heavy Users before response times started to increase markedly, validating the optimal value of 288 Heavy Users derived using **% Processor Time** values.

Test analysis summary

Figure 5 summarizes the optimal numbers of users supported by the HP ProLiant DL585 G5 server.

Figure 5. Optimal numbers of users supported in the 64-bit test harness
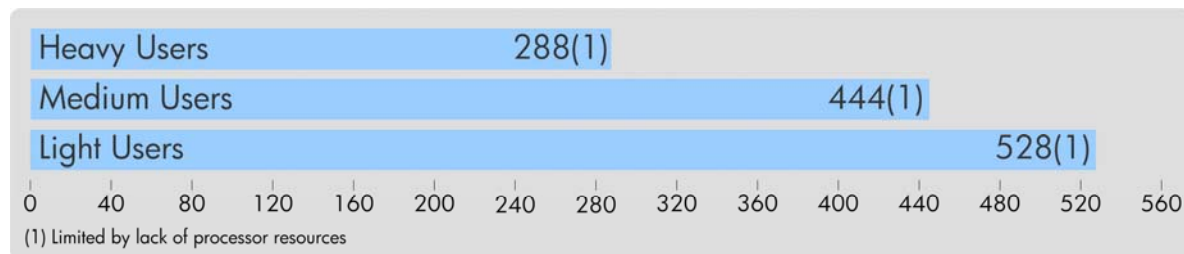
HP characterized the scalability of the HP ProLiant DL585 G5 server through the numbers of users supported when CPU utilization reached 80%.

Recommendations

Since x64 platforms allow you to better utilize memory and multi-core processors, the bottleneck you are most likely to encounter[6] is associated with the disk subsystem. While a detailed analysis of disk I/O performance is beyond the scope of this white paper, the following observations are offered to help you improve disk performance:

- Utilize battery-backed write cache (see Using BBWC).
- Since built-in storage is often insufficient to support a large number of users in an HP SBC environment, consider deploying additional RAID arrays/SAN support.
  Note also that when a SCSI RAID array is used to host user profiles and page files, the number of spindles deployed has a significant impact on the response times associated with file access.
- When the pressure on the disk I/O subsystem is high, one option for improving disk access times is to add RAM to lower the pressure on memory.
  As the number of sessions increases, disk activity and the pressure on the disk I/O subsystem also increase. If file I/O activity is high, the probability that requests will find the desired data in memory decreases, thus negatively affecting file access times.

To help avoid a disk I/O bottleneck, Microsoft recommends using the Windows performance monitoring tool, Perfmon, to check the following metrics[7]:

- **%Idle time** – Idle times for logical and physical drives should average at least 50%
- **Average Disk Seconds/Read** and **Average Disk Seconds/Write** – The average time taken to complete a read or write should average less than 25 milliseconds, with peaks less than 50 milliseconds

If the above conditions specified by Microsoft cannot be met, a disk I/O bottleneck is likely.

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[6] For further information, refer to the HP white paper, "Scalability and performance of HP ProLiant servers on 64-bit Microsoft Windows Server 2003 in an HP SBC environment."
[7] For further information, visit the Microsoft website; click the **Start download** link.

Using BBWC

HP Smart Array controllers include an allocation of RAM that can be utilized to temporarily buffer data being written to or read from disk. Since access to this RAM is significantly faster than disk access, cache can enhance overall server performance, particularly during login operations.

Write cache is of particular interest in the HP SBC environment. After buffering all the data associated with a particular write command, the Smart Array controller indicates to the HP SBC server that the data transfer to the disk is complete – even through the data is still being written to disk. This frees up the server's processor to perform other tasks and accelerates data throughput.

Performance improvements from write cache are typically most significant when the HP SBC server is performing log-intensive operations and/or when significant page file write operations are necessary, such as during user logins. Lab testing has demonstrated performance gains ranging from 50% to 250%[8]; actual results will vary depending on the application(s) involved and your particular HP SBC environment.

Enabling write cache

While faster access times can translate directly to enhanced system performance, this improvement comes with a potential penalty: if a system or utility failure were to occur during cache synchronization, data might be lost unless battery back-up has been provided.

Because of the potential for data loss, write cache is automatically disabled on HP SBC servers unless an optional Battery Backed Write Cache (BBWC)[9] enabler is installed and fully-charged. BBWC allows you to cache write data safely, knowing that your data would be protected by the battery in the event of a system or controller.

HP highly recommends implementing BBWC on every HP SBC server.

Summary

When planning an x64 HP SBC environment, you should select servers equipped with multi-core processors to help maximize scalability. If your budget allows, consider the fastest processors, the most cores, and largest cache.

Memory is an important factor in the x64 environment: while an x64 platform can utilize more RAM, it also has a higher minimum RAM requirement than an x86 platform. Since a system that is not memory-starved may also prevent disk I/O bottlenecks, HP recommends adding as much RAM as your budget permits.

For optimal performance, ensure that BBWC is implemented and enabled, in conjunction with the largest possible controller cache. Consider using 15,000 rpm SAS drives.

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[8] For further information, visit the HP website
[9] BBWC is available as an option for select HP ProLiant servers.

Appendix A – Using Microsoft Windows Server 2003 x64 Editions

Microsoft offers high-performance platforms for 64-bit applications with continued support for 32-bit applications and existing deployment and management tools – all on the same platform. These operating systems provide an evolutionary path to 64-bit technology, allowing 64-bit and 32-bit applications to run side-by-side during the gradual migration to 64-bit computing.

64-bit editions of Windows Server 2003 running on Quad-Core AMD Opteron processors can improve the performance of HP SBC servers by processing more data per clock cycle, addressing more memory, and running some numerical calculations faster. Large data sets can be loaded entirely into memory, reducing the need for slower disk access; complex calculations that take hours to complete on a 32-bit system can be performed in minutes; and workloads that once required a large server farm can be performed by a single server.

In addition, this 64-bit platform also removes many of the limitations that have previously inhibited scalability in an HP SBC environment.

Historical scalability limitations

32-bit Windows operating systems can directly address 4 GB of memory, 2 GB of which is reserved for the operating system kernel and 2 GB for applications. Since kernel memory is shared by all applications, the relatively small size of this space can be particularly problematic in an HP SBC environment where a server may be responsible for hundreds of users and thousands of processes. In this scenario, kernel memory can become constrained, making user response times unacceptably long and effectively limiting the ability of the server to scale up.

Historically, HP SBC environments have been implemented using 1P or 2P servers. Larger, more powerful servers have typically not been deployed for two main reasons:

- Kernel memory issues have limited the performance of more powerful servers; either a disk I/O bottleneck occurs or kernel memory is consumed before processor resources can be fully utilized
- Scalability in a 32-bit symmetric multi-processing (SMP) system is inherently non-linear above 2P

With these 1P and 2P server farms, opportunities to scale up are limited. As a result, customers are forced to scale out, which can create new problems such as deployment and management complexity, high power and cooling requirements, under-utilized resources, and minimal opportunities for server consolidation.

The 64-bit platform shatters the earlier 4 GB limitation – for example, Windows Server 2003 R2 Datacenter x64 Edition with Service Pack (SP) 1 supports up to 2 TB of RAM – effectively removing kernel memory limitations and eliminating disk I/O bottlenecks. By deploying a Windows Server x64 Edition operating system, you can fully utilize the resources of your existing HP SBC servers and take full advantage of new, more powerful systems – whether you are running 32- or 64-bit applications.

More information

For more information on the impact of 64-bit Windows Server 2003 x64 Editions in an HP SBC environment, refer to the HP white paper, "Scalability and performance of HP ProLiant servers on 64-bit Microsoft Windows Server 2003 in an HP SBC environment."

To learn about 64-bit computing in an HP SBC environment, refer to the HP white paper, "Fundamentals of 64-bit computing in an HP SBC environment."

Appendix B – SBC solution sizing

As with any laboratory benchmark, the performance metrics quoted in this performance brief are idealized. In a production environment, these metrics may be impacted by a variety of factors, including the following:

- **Overhead**
  Agents and services (virus scanning, backup and restore, provisioning, security, management and more) automatically consume overhead. Rogue applications can consume additional overhead. The system architect may wish to provide a 25% – 30% buffer to accommodate this overhead.

- **Future growth**
  To accommodate future growth, the system architect may wish to provide an additional buffer. Alternatively, servers can be added as needed, taking advantage of the server farm's inherent ability to scale out.

- **User profiles**
  The particular application in use directly impacts the number of users supported by a particular server. Further, user behavior can also impact scalability:

  – Increased typing rates correspond to fewer users.

  – Opening and closing applications (rather than switching between them) or moving quickly between tasks can place a heavier load on the server.

  – For accurate sizing, system architects should closely match their user profiles with the Heavy, Medium, and Light User profiles specified by HP in Table 2. If the profiles do not match, more are available using the online sizer tool (described below); alternatively, the system architect can consult HP Services for more information.

- **Background grammar checking**
  Background grammar checking can significantly impact scalability, reducing the number of users supported by as much as 50%. HP disabled background grammar checking for the testing described in this performance brief.

Online sizer tool

To minimize risk, HP offers automated, online tools that can help the customer size an HP SBC solution. The algorithms and methodology used by the sizer are based on the results of customer surveys and thorough testing.

An HP ProLiant Sizer for Citrix XenApp and Microsoft Windows Server 2003 Terminal Services is available for enterprise and small and medium business (SMB) environments. Figure B-1 shows the **Application Selection** screen for this sizer.

Figure B-1. The sizer's **Application Selection** screen

Based on information provided by the customer, the sizer can provide a quick, consistent mechanism for identifying the "best-fit" server for a particular HP SBC environment and generate a Bill of Materials (BOM) for that server.

For more information

HP ProLiant DL585 G5 server	http://www.hp.com/servers/dl585
HP ActiveAnswers for Server Based Computing	http://www.hp.com/solutions/activeanswers/hpsbc
HP ProLiant Sizer for Citrix XenApp (formerly Presentation Server) and Microsoft Windows Server 2003 Terminal Services	http://h71019.www7.hp.com/activeanswers/Secure/70245-0-0-0-121.aspx
HP Services	http://www.hp.com/hps/
HP Solution Centers	http://www.hp.com/go/solutioncenters
Introduction to Windows Server 2003 operating systems	http://www.microsoft.com/windowsserver2003/evaluation/overview/family.mspx
Technical overview of Windows Server 2003 Terminal Services	http://www.microsoft.com/windowsserver2003/techinfo/overview/termserv.mspx
Citrix XenApp	http://www.citrix.com/site/PS/products/feature.asp?familyID=19&productID=186&featureID=4110
Quad-Core AMD Opteron processors	http://multicore.amd.com/us-en/AMD-Multi-Core.aspx
AMD PowerNow! Technology	http://www.amd.com/powernow

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